



GEOLOGICAL MONSTERS

OF

PRE-ADAMITE TIMES,

AS RESTORED AT THE PALACE GARDENS OF SYDENHAM, AND THEIR
REMAINS PRESERVED IN THE MUSEUMS OF LONDON.

BY THE AUTHORESS OF "PRE-ADAMITE MAN."



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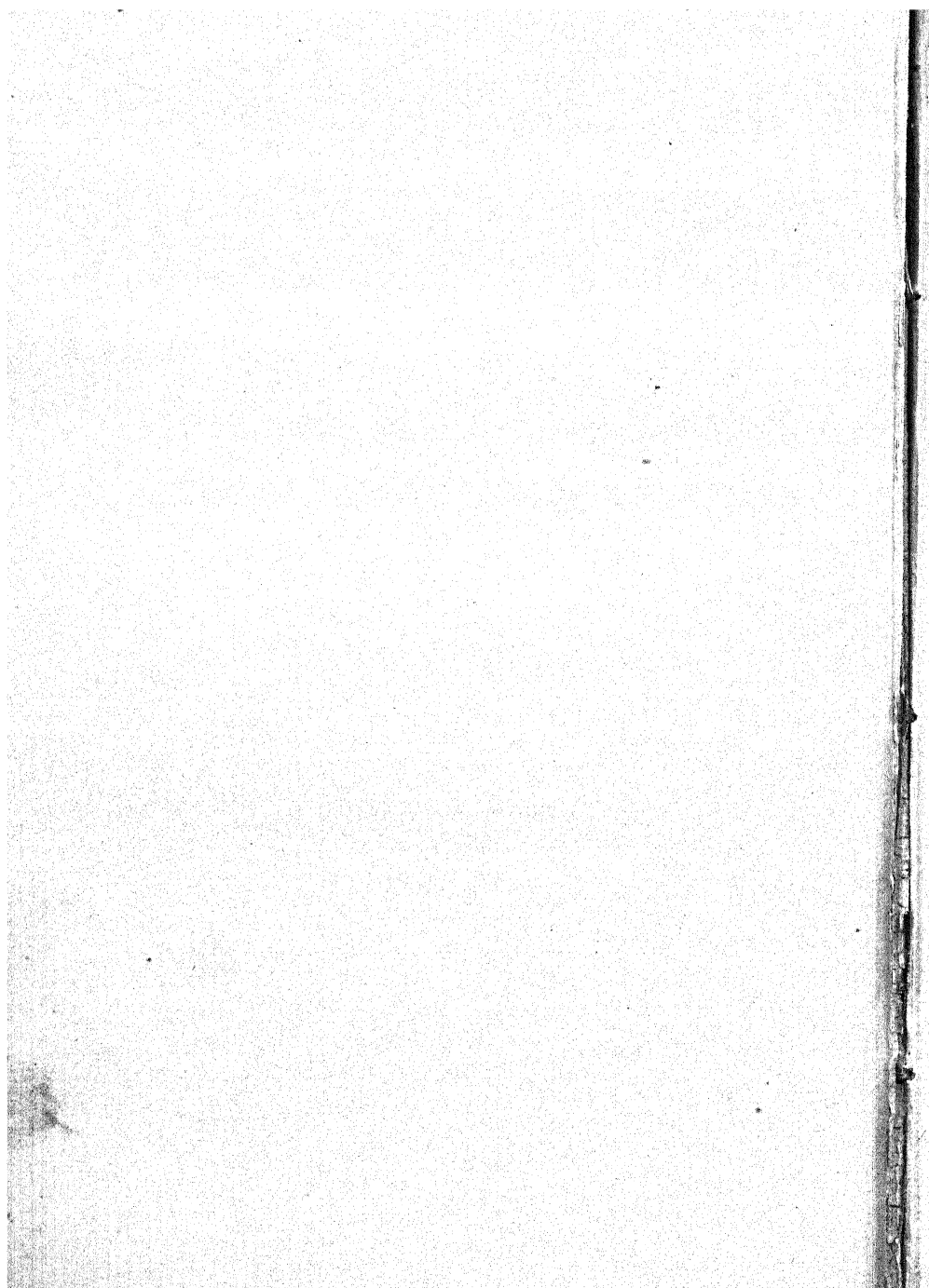
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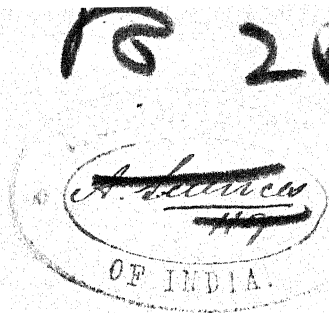
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GEOLOGICAL WONDERS OF LONDON.

INTRODUCTION.

FEW objects can be more interesting to strangers visiting London, than to examine for themselves the singular remains, disclosed by geologists, which have been gathered into some of the museums of the metropolis. In addition to the British Museum, where a vast multitude of fossils of all ages has been accumulated, we would earnestly recommend a visit to the Museum of Practical Geology, in Jermyn Street, and to the Crystal Palace, at Sydenham, where the clever restorations of Mr. Waterhouse Hawkins have greatly added to the attractions of the gardens.

In viewing the monster models there to be seen, it will not be wonderful if those who have

been unaccustomed to the contemplation of geological forms, should feel some suspicion of the truthfulness of such singular delineations. A proper investigation of the subject, however, will dissipate such doubts. It is to the genius of Cuvier, and of Owen, that we owe the careful and accurate description of animals, which never have been seen in their living embodiment by mortal eyes. As a clever mechanic, when furnished with the materials of a complicated engine, will be at no loss to put them together, or to supply such parts as may happen to be lacking,—so, from the fossil remains which have been discovered in the rocks, have these great men been able to describe, without hesitation, the animal frameworks of which Mr. Hawkins has here presented us with the embodied forms.

“I cannot express my delight,” says Cuvier, “on finding how the application of one principle was instantly followed by the most triumphant results. The essential character of a tooth, and its relation to the skull being determined, immediately all the other elements of the fabric fell into their places; and the vertebræ, ribs and bones of the legs, thighs, and feet, seemed to arrange themselves even without my bidding, and precisely in the manner which I had predicted.”

It was not till after the middle of the last

century, that the science of geology attracted any very special attention. About this time, M. Guettard collected, and attempted to classify, many fossil bones and teeth of extraordinary size: and two years afterwards, the discovery was made to which Dr. Mantell alludes in what follows:—

In 1770, M. Hoffman, who was forming a collection of organic remains, had the good fortune to discover a specimen, which has conferred additional interest on this locality (St. Peter's near Maestricht.) Some workmen, in blasting the rock in one of the caverns of the lower mountain, perceived to their astonishment, the jaws of an enormous animal attached to the roof of the chasm. The discovery was immediately made known to M. Hoffman, who repaired to the spot, and for weeks presided over the arduous task of separating from the rock, the mass of stones containing these remains. His labours were at length repaid by the successful extrication of the specimen, which he conveyed in triumph to his house. Unfortunately, the canon of the Cathedral which stands on the mountain, claimed the fossil in right of being lord of the manor, and succeeded by a vexatious and expensive lawsuit, in obtaining possession of this precious relic. It remained in his possession for years, and Hoffman died with-

out regaining his treasure, or receiving any compensation.

The French Revolution broke out, and the armies of the Republic advanced to the gates of Maestricht; the town was bombarded, but by the desire of the committee of *savans* who accompanied the French troops, the artillery was not allowed to play upon that part of the city in which the celebrated fossil was known to be contained. In the mean time, the canon, shrewdly suspecting the reason why such peculiar favour was shown to his residence, concealed the specimen in a secret vault; but when the city was taken, the French authorities compelled him to give up his ill-gotten prize, which was immediately transmitted to the *Jardin des Plantes*, at Paris, where it still forms one of the most striking objects in that magnificent collection.

It consists of the jaws, teeth, palate-bones, vertebræ, and *os quadratum*, a bone possessed by some reptiles, and in which the auditory cells are contained. The original was a reptile, holding an intermediate place between the Monitor and the Iguana, about twenty-five feet long. Its tail seems to have acted as a powerful oar, enabling the animal to stem the waves of the ocean, of which Cuvier supposes it to have been an inhabitant. A few remains of this reptile have been met with, near Lewes and Brighton. Teeth

have occurred in Kent and Essex. They are also found in some parts of North America.

This singular history gave an impulse to geological discovery, which it never before had received; and from that period, till our own day, fresh accessions have everywhere been made to collections, both public and private, of fossil objects of curiosity and interest. The sources whence these are chiefly derived, will be alluded to as we proceed; and it must be interesting to all intelligent inhabitants of our island, to know that there is scarce a region of the world more prolific in these wonders than our own.

For the sake of those who may be quite tyros in this science, I have provided two diagrams, by means of which I trust the interest of the reader will be excited and sustained. The smaller is a plain wood-cut, intended to illustrate the earth's crust, and the strata that compose it. The larger is meant to give an idea of the changes which have taken place in the character of the productions of our earth, and in its conditions at certain great eras in its history.

Referring to the smaller diagram, the reader will observe that it presents the appearance of a section of the earth's crust, in which are marked various strata, the geological designations of which are named in the margin.

There may be no spot on which all the various kinds of rock are to be found together, but we may be tolerably sure that no species exists either higher or lower, with reference to the rest, than that position which science has assigned to it. Like the numbered pages of a book, which, though some may be torn from it, will still occupy their own place, the rocks ascertained, described, and named, lie thus regularly disposed from the lowest to the highest.

In many places the granite, obtruding through the rest, is found at the surface, and there we know that it is hopeless to look for any other kind of rock; for beneath the granite no other rock has yet been found. In many others we find coal, and there we always expect, in penetrating deeper, to come to granite at last, but ere reaching it, we may have to pass through various strata of sandstone or slate, though some, if not all of these, may be wanting. But we are sure that it would be vain for us to expect there to find chalk, or green sand, or oolite, because these belong to a later and higher formation. So constantly do these rocks keep their relative places in the geological system of the globe.

In calculating the period that must have elapsed since the world began, we must allow whatever is needful to account for the construc-

tion of each of these rocky leaves of our mundane book ; and the perpendicular thickness of these, in the aggregate, from the granite upwards, if it were possible to place them one upon another, would amount, according to Sir Roderick Murchison, to not less than fifteen miles, the larger portion of which are found filled with vegetable and animal remains !

Our object being to direct our readers to the higher forms of ancient life, we shall not linger among the earlier strata where molluscs and fishes are chiefly to be found, but ascending through the Silurian, the Old Red or Devonian, and the Carboniferous groups we shall find ourselves at length in one great division of the creatures of which we are now speaking, and which abound in the higher rocks of the secondary series, particularly in those of the Oolite, the Lias, and the Chalk. Thence, still ascending, we shall see a second division of these creatures existing in great variety in all the Tertiary Rocks, and becoming, as we rise, more and more like those of our own day.

The Large Plate is arranged with a view of illustrating this progress. The lower portion of the picture shows some of the forms, of which the remains exist in the Secondary Rocks.

The section immediately above it contains several of the more important animals of the

Tertiary, showing the growing elegance and perfection of the later forms of life, as well as their diminished, though still gigantic, proportions. Many of both have been illustrated by the clever restorations of the Crystal Palace.

The next section is intended to draw attention to the state of the earth during the period between the tertiary and recent times when, according to Agassiz and many modern philosophers, a glacial invasion spread destruction over it; and the highest portion of the plate refers to the state of the Animal Creation of our own days.

What follows is meant to illustrate these objects.



CHAPTER I.

THE ANIMAL MONSTERS OF THE SECONDARY AGE.

“THE oldest known reptiles,” says Miller, “appear a little before the close of the old red sandstone, just as the oldest known fishes appeared a little before the close of the Silurian system. What seems to be the upper old red of our own country, though there still hangs a shade of doubt on the subject, has furnished the remains of a small reptile, equally akin, it would appear, to the lizards and batrachians; and what seems to be the upper old red of the United States has exhibited the foot-tracks of a larger animal of the same class, which not a little resemble those which would be impressed on recent sand, or clay, by the alligator of the Mississippi, did not that animal efface its own foot-prints, (a consequence of the shortness of its legs.) In the coal measures the reptiles hitherto found are all allied to the batrachian order

—that lowest order of the reptiles to which the frogs, the newts, and salamanders belong. These reptiles of the carboniferous era, though, only a few twelvemonths ago," he continues, "we little suspected the fact, seem to have been not very rare in our own neighbourhood, (Edinburgh.) My attention was called some time since by Mr. Henry Cadell, an intelligent practical geologist, to certain appearances in one of the Duke of Buccleuch's coal pits, near Dalkeith, which he regarded as the tracks of air-breathing quadrupeds; and after examining a specimen, containing four foot-prints, which he had brought above ground, and which not a little excited my curiosity, we visited the pit together. Enough remained to show that at that spot, little more than a mile from where the duke's palace now stands, large reptiles had congregated in considerable numbers, shortly after the great eight feet coal seam of the Dalkeith basin had been formed, In another part of the pit I found foot-tracks of apparently the same animal in equal abundance, but still less distinct in their state of keeping. Close upon these strata, but above them, lies the new red sandstone, and higher still the lias, the oolite, and the chalk, rising in succession and forming that extensive group of rocks, known by geologists as "The Secondary Formation."

The remains of land tortoises have been rarely

discovered in a fossil state, and these generally in very recent formations. But in the new red sandstone evidence exists that at the period of which we are now speaking, Scotland had more than one species of this terrestrial reptile. The nature of this evidence, Buckland asserts, was almost unique in the history of organic remains, when their original tracks, buried to the depth of many feet in the solid sandstone of Dumfriesshire, were brought to light by Dr. Duncan. This discovery was afterwards followed by others, confirming the conclusion that such reptiles had existed in this early era over the greater part of Europe.

England, which contains, (with few exceptions,) the whole succession from the granite to the highest of these rocks, offers in many parts of the country, and among others in the region along its southern coast, from Dorsetshire to the cliffs of Dover, a most instructive field of geological inquiry in this prolific group. Mingled with the remains of gigantic winged creatures of forms unknown in our day, have been there found the bones of creatures which seem the exaggeration of all that we know of existing reptiles. The lizard tribe, for example, is represented by remains, which must have belonged to animals of that race hideously larger than any now existing in the world. Forms to our eyes

monstrous and forbidding, which once crawled, and waded, and grovelled, on the muddy surface of a world still weltering beneath the dripping atmosphere of the first days of direct sunlight, have left their skeletons in whole, or in part, in what is now the solid rock.

Sea animals, air-breathing, and in some respects resembling crocodiles, fill a considerable space in the observations we make in these rocks. Some of these animals have been very carefully restored, and the genius of Cuvier, of Owen, and others has succeeded in delineating to the general satisfaction of men of science, the form and character that must have belonged to these beings when they lived and moved upon earth.

“The seas were now inhabited,” says professor Lardner, “by monstrous animals endowed with vast powers of aquatic locomotion, called ichthyosaurus and plesiosaurus, whose oar-like feet resembled those of the present sea tortoise. The same age also produced in abundance those flying saurians, or lizards, to which palæontologists have given the name of pterodactyle or “wing-fingered.” All these gigantic tribes became extinct at the close of the age of which we speak. They are accompanied by many other giants of various types. The two genera of birds called palæornis and cimiliornis were of enormous proportions, and they seem to have been

among the first of the kind which had yet appeared. Foot-prints of birds have been discovered in several quarries of secondary rock in America, specimens of which are to be seen in Room No. 6 of the Geological Gallery at the British Museum. One of these prints, which measures fifteen inches in length, must have belonged to a bird of extraordinary size. The iguanodon, a land-lizard seventy feet in length, of the bones of which there are many specimens in the Museum, must have fed on the gigantic ferns and conifers which constituted an important part of the vegetation of this period. "In the times of the oolite," Miller tells us, "the reptilian class dominated everywhere and possessed itself of all the elements. Gigantic enaliosaurus, huge reptilian whales mounted on paddles, were the tyrants of the ocean, and must have reigned supreme over the already reduced class of fishes. Pterodactyles, dragons as strange as were ever feigned by romances of the middle ages, and that to the jaws and teeth of the crocodile added the wings of a bat, and the body and tail of an ordinary mammal, had "the power of the air," and pursuing the fleetest insects in their flight, captured and bore them down.

"Some of these dragons of the secondary ages were of very considerable size. The wings of the pterodactyles of the chalk, in the possession of

Mr. Bowerbank, must have had a spread of about eighteen feet; those of a recently discovered pterodactyle of the greensand, a spread of not less than twenty-seven feet. The lammergeyer of the Alps, one of the largest existing European birds, has an extent of wing of but from ten to eleven feet; while that of the great condor of the Andes, the largest of flying birds of our own age, does not exceed twelve feet.

“The lakes and rivers of the oolitic period abounded in crocodiles and fresh-water tortoises of ancient type and fashion, and the woods and plains were the haunts of strange reptilian forms of what have been well termed ‘fearfully great lizards,’ some of which, such as the iguanodon, rivalled the largest elephant in height, and greatly more than rivalled him in length and bulk. No fragments of the skeletons of birds have yet been discovered in formations older than the chalk. The Connecticut remains are those of foot-prints exclusively, and yet they tell their extraordinary story, so far as it extends, with remarkable precision and distinctness. The bones of *Dinornis giganteus*, exhibited by the late Dr. Mantell in Edinburgh, in the autumn of 1850, greatly exceeded in bulk those of the largest horse. A thigh bone, sixteen inches in length, measured nearly nine inches in circumfer-

ence. It was estimated that a foot, entire in all its parts, which formed an interesting portion of the exhibition, would, when it was furnished with nails, and covered by the integuments, have measured about fifteen inches in length, and it was calculated by a very competent authority, Professor Owen, that, of the other bones of the leg to which it belonged, the tibia must have been about two feet nine inches, and the femur about fourteen and a half inches long. The larger thigh-bone referred to must have belonged, it was held, to a bird that stood from eleven to twelve feet high, the extreme height of the great African elephant!

“We have already referred to flying dragons, real existences of the oolite period, that are quite as extraordinary of type, if not altogether of so large of bulk, as those with which the seven champions of Christendom used to do battle, and here we are introduced to birds of the Liassic ages that were scarce less gigantic than the roc of Sinbad the sailor. They are fraught with strange meanings, these foot-prints of the Connecticut. They tell of a time far removed into the by-past eternity, when great birds frequented by myriads the shores of a nameless lake, to wade into its shallows in quest of mail-covered fishes of the ancient type, or long extinct molluscs; while reptiles, equally enormous, and of still stranger

proportions, haunted the neighbouring swamps and savannahs; and when the same sun that shone on the tall moving forms beside the waters, and threw their long shadows across the red sands, lighted up the glades of deep forests, all of whose fantastic productions, tree, bush, and herb, have, even in their very species, long since passed away.”¹

It would appear from the examination of various regions of the earth, from the Arctic Ocean southwards to forty degrees of north latitude, that the climates were universally of the same tropical character, and probably uniform and without distinction of seasons, favouring the multiplication of their tribes, and their general distribution over the earth.

A few of these may be well worthy of our more particular examination, by the aid of such remains and restorations as are within reach, and our plate is intended to help the enquiry.

1. Pterodactyle, No. 7 on the plate; (pteron, a wing; dactylos, a finger. Remains in British Museum, Geological Department, Room III. Crystal Palace Restorations, Sydenham.) A flying reptile, of a most remarkable character, presenting more singular combinations than we find in any other creatures yet discovered in the ancient earth. The remains of this fossil

¹ “Testimony of the Rocks,” page 76, &c.

animal have hitherto been found chiefly in the quarries of lithographic limestone of the Jura formation at Aichstadt and Sobenhofen, but have also occurred in the oolitic slate of Stonesfield and in the middle chalk of Kent. The form of its head and neck resembles those of a bird; its wings are like the wings of a bat; and the body and tail approximate to those of the mammalia. These characters, connected with a small skull, as is usual among reptiles, and a beak furnished with not less than sixty pointed teeth, presented a combination of apparent anomalies which it was reserved for the genius of Cuvier to reconcile. In the pterodactyle, he shows how the fore-leg of the modern lizard is converted into a membraniferous wing, and the other parts of the reptile-body fitted for the functions of flight. These animals somewhat resemble our modern bats or vampires, having the nose elongated like the crocodile, and armed with conical teeth. Their enormous eyes fitted them to fly by night, and the hooks on their wings would serve to enable them to suspend themselves from trees or projecting rocks. This animal probably also possessed the power of swimming, and like Milton's fiend, qualified for all services and all elements, the creature was thus a fit companion for the kindred reptiles that swarmed in the seas or crawled on the shores of a turbulent planet.

“ The fiend,
O'er bog or steep, through strait, rough, dense, or rare,
With head, hands, wings, or feet, pursues his way,
And swims, or sinks, or wades, or creeps, or flies.”

We are indebted to Dr. Buckland for the graphic description of this singular animal, which we have here abridged, as he was to Cuvier for the anatomical demonstration of its singular and complicated structure.

2. Iguanodon—three specimens, No. 8, 11, and 15 on plate, (iguana, a species of modern reptile; odous, a tooth.—Remains in British Museum, Geological Department, Room No. III, cases 8 and 9. Crystal Palace Restorations.) A very large reptile of the Wealden, so called from the similarity of its dentition to that of the modern iguana, leaving, no doubt, that like the latter animal it was herbivorous, or at least did not partake of the fiercer qualities of the crocodiles to which it is allied. The measurement which Dr. Mantell made of such bones as he procured, belonging to eight individuals, led him to conclude that it must have reached a length of seventy feet, of which fifty-two and a half went to the tail; the circumference of the body, he calculates, must have been fourteen feet and a half; the construction of the limbs indicates the animal to have been intended for existence on land. It has been ascertained that, like the

iguana, the iguanodon had a horn of bone upon the nose, affording one of many proofs of the universality of the laws of co-existence. This animal is one of the modern discoveries for which we are indebted to the vigilance of a lady. Mrs. Mantell, in one of her walks in Tilgate Forest, saw, in the coarse conglomerate, some teeth of a fossil animal, very large and hitherto unknown, which she brought to her husband, the afterwards accomplished and well-known geologist, by whom many specimens, evidently belonging to animals of the same race, but at different stages of their growth, were afterwards collected, and with the help of Baron Cuvier and Professor Owen were duly arranged. From these the figure of the iguanodon, as we see it reared in the Crystal Palace Grounds under the eye of Mr. Hawkins, was restored, and the following account by that gentleman, will doubtless be interesting to many of my readers, as it furnishes a graphic history of a most important effort in the direction of popular education in the walks of science:

“ These restorations of the iguanodon I made from the measurements of the great Horsham specimen, as the largest is called, from its having been found and carefully preserved by Mr. Holmes, surgeon, at Horsham, who has bestowed much care and attention on the development of

the great fossils found in his neighbourhood, among which are the largest known specimens of the bones of the iguanodon, having also the greater value of being found all together, evidently belonging to one individual. These he kindly placed at my service for comparison with the better known Maidstone specimen now in the British Museum, which was so admirably extricated from its matrix and preserved by Mr. Benstead and Dr. Mantell.

“ This iguanodon was the animal the mould of which I converted into a *salle à manger*, and in which I had the honour of receiving Professor Owen, Professor E. Forbes, and twenty of my scientific friends to dinner on the last day of the year 1853. This circumstance will best illustrate the great size of these animals, the restoration of which has involved some of the greatest mechanical difficulties that can come within the sculptor's experience; and, if it will not be considered out of place, I will briefly state the process by which I have constructed these large models.

“ In the first week of September, 1852, I entered upon my engagement with the Crystal Palace Company to make the Mastodon, or any other models of the extinct animals that I might find most practicable; such was the tenor of my undertaking, and being deeply impressed with

its important and perfectly novel character, without precedent of any kind, I found it necessary, earnestly and carefully, to study the elaborate descriptions of Baron Cuvier, but more particularly the learned writings of our British Cuvier, Professor Owen. Here I found abundant material collected together, stores of knowledge from years of labour, impressing me still more with the grave importance of attempting to present to the eye of the world at large, a representation of the complete and living forms of those beings, the minutest portion of whose bones had occupied the study and research of our most profound philosophers; by the careful study of their works, I qualified myself to make preliminary drawings, with careful measurements of the fossil bones in the Museum of the College of Surgeons, British Museum, and Geological Society; thus prepared, I made my sketch-models to scale, either a sixth or a twelfth of the natural size, designing such attitudes as my long acquaintance with the recent and living forms of the animal kingdom enabled me to adapt to the extinct species I was endeavouring to restore. These sketch-models I submitted in all instances to the criticism of Professor Owen, who, with his great knowledge and profound learning, most liberally aided me in every difficulty. As in the first instance it was by the light of his writings

that I was enabled to interpret the fossils that I examined and compared, so it was by his criticism that I found myself guided and improved, his profound learning being brought to bear upon my exertions to realise the truth. His sanction and approbation obtained, I caused the clay model to be built, of the natural size by measurement, from the sketch-model, and when it approximated to the form, I, with my own hand, in all instances secured the anatomical details and the characteristics of its nature.

“Some of these models contained thirty tons of clay, which had to be supported on four legs, as their natural history characteristics would not allow of my having recourse to any of the expedients for support allowed to sculptors in an ordinary case. I could have no trees, nor rocks, nor foliage to support these great bodies, which, to be natural, must be built fairly on their four legs. In the instance of the iguanodon, it is not less than building a house upon four columns, as the quantities of material of which the standing iguanodon is composed, consist of 4 iron columns 9 feet long by 7 inches diameter,

“ 600 bricks,

“ 650 2-inch, half-round drain tiles,

“ 900 plain tiles,

“ 38 casks of cement,

“ 90 casks of broken stone,

making a total of 650 bushels of artificial stone.

“ These, with 100 feet of iron hooping and 20 feet of cube inch bar, constitute the bones, sinews, and muscles of this large model, the largest of which there is any record of a casting being made.

“ I have only to add that my earnest anxiety to render these restorations truthful and trustworthy lessons, has made me seek diligently for the truth and the reward of Professor Owen’s sanction and approval, which I have been so fortunate as to obtain, and my next sincere wish is that, thus sanctioned, they may, in conjunction with the visual lessons in every department of art, so establish the efficiency and facilities of visual education, as to prove one of many sources of profit to the shareholders of the Crystal Palace Company.”

3. *Megalosaurus*, No. 8 in plate, (megas, great ; sauros, lizard. Remains, British Museum, Room III, Case 8. Crystal Palace Restorations). This monstrous reptile was carnivorous, and frightfully endowed with weapons, wherewith, doubtless, it waged a deadly and destructive warfare with its less formidable contemporaries. Its teeth were fearfully fitted to the destructive habits which must have belonged to it, presenting, as Dr. Buckland remarks, a combination of the human

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contrivances exemplified in the knife, the sabre, and the saw. Its remains have been found in the oolitic slate of Stonesfield, near Oxford; in the wealden of Tilgate Forest; in the ferruginous sand of the same age in Cuckfield, in Sussex; in the Purbeck limestone of Swanage Bay; and in the oolite of Malton, in Yorkshire. Cuvier conjectured that the animal may have reached a length of forty or fifty feet, but later observations limit it, in the largest specimen discovered, to thirty-seven feet. This animal, as represented by Mr. Waterhouse Hawkins at the Crystal Palace, accordingly measures this length. The head is five feet, the tail fifteen feet long, and the girth of the body twenty-two feet six inches, and from the length and structure of the legs it must have stood higher than its congener, the *iguanodon*.¹

4. *Labyrinthodon*, No. 10 in plate, (*labyrinthos*, a labyrinth; and *odous*, a tooth; Remains, British Museum, Room No. III. Jermyn Street Museum. Crystal Palace Restorations); an animal deriving its name from the structure of its teeth, which present a singularly intricate pattern on their opposing surfaces, and thus suggest the idea which it expresses. It has also been called *cheirotherium* (*cheir*, hand; *therion*, beast), from the hand-like impression made on

¹ Buckland, Mantell, Hawkins, Owen.

the sand on which it trod, where, having become hardened into stone, it remains to this day as clearly marked as the device of a well-cut seal on wax. The formation in which these singular memorials of the animal in question have come to light, is the New Red Sandstone, which lies above the coal, and they occur in many parts of England. They seem to have been contemporary with the tortoise, whose traces were found by Dr. Duncan in the New Red of Dumfriesshire.

The form of the labyrinthodon is to some extent conjectural, though enough has been discovered to warrant the correctness of the general features of the animal, as delineated by Mr. Hawkins and transferred to our plate; the skull, some fragments of bones of the limbs, and several vertebræ, together with the footmarks referred to, have suggested the details of this restoration. Nothing can well be more striking to an observer than the extraordinary likeness which these footmarks bear to a human hand, though somewhat exaggerated in size and proportions. A young friend who accompanied the author on a visit to the Geological Museum, at once suggested that the prints which attracted and riveted his attention must have been those of our Pre-Adamites, and he added, "They were surely giants." He did not take into account

the fact that the animal, whose traces he here saw, was evidently four-footed, and that the fingers were too clumsy for a race of men to have left imprinted "on the sands of time."

5. Plesiosaurus, No. 12 in plate, (plesios, nearer to; sauros, lizard. Remains, British Museum, Rooms No. III and IV. Jermyn Street Museum. Crystal Palace Restorations), so called from the approach which it makes in several respects to the structure of the lizard tribe. Cuvier, in his "Ossemens Fossils," asserts its characters to have been the most strange and monstrous that have yet been found amid the ruins of a former world. To the head of a lizard it united the teeth of a crocodile: a neck of enormous length, resembling the body of a serpent; a trunk and tail having the proportions of an ordinary quadruped, the ribs of a chameleon, and the paddles of a whale. Such are the strange combinations of form and structure in the plesiosaurus—a genus, the remains of which, after interment for thousands of years amidst the wreck of millions of extinct inhabitants of the ancient earth, are at length recalled to light by the researches of the geologist, and submitted to our examination in nearly as perfect a state as the bones of species that are now existing upon the earth. The plesiosaurs appear to have lived in shallow seas and estuaries, and to have

breathed air, like the ichthyosauri and our modern cetacea. The most anomalous of all the characters of plesiosaurus is the extraordinary extension of the neck, to a length almost equalling that of the body and tail together, and surpassing in the number of its vertebræ (about thirty-three) that of the most long-necked bird, the swan.

We shall presently find in the habits of the plesiosaurus a probable cause for this extraordinary deviation from the normal character of the lizards. The tail, being comparatively short, could not have been used, like the tail of fishes, as an instrument of rapid impulsion in a forward direction; but was probably employed more as a rudder to steer the animal when swimming on the surface, or to elevate or depress it in ascending and descending through the water.

The same consequences as to slowness of motion would follow from the elongation of the neck to so great a distance in front of the anterior paddles. The total number of vertebræ in the entire column was about ninety.

From all these circumstances we may infer that this animal, although of considerable size, had to seek its food, as well as its safety, chiefly by means of artifice and concealment.

As the plesiosaurus breathed air, and was, therefore, obliged to rise often to the surface

for respiration, this necessity was met by an apparatus in the chest and pelvis, and in the bones of the arms and legs, enabling it to ascend and descend in the water after the manner of the ichthyosauri and cetacea; accordingly, the legs were converted into paddles, longer and more powerful than those of the ichthyosaurus, thus compensating for the comparatively small assistance which it could have derived from its tail.

From the consideration of all its characters, Mr. Conybeare has drawn the following inferences with respect to the habits of the plesiosaurus:

“That it was aquatic is evident from the form of its paddles; that it was marine, is almost equally so from the remains with which it is universally associated; that it may have occasionally visited the shore, the resemblance of its extremities to those of the turtle may lead us to conjecture; its motion, however, must have been very awkward on land; its long neck must have impeded its progress through the water; presenting a striking contrast to the organization which so admirably fits the ichthyosaurus to cut through the waves.

“May it not, therefore, be concluded (since in addition to these circumstances, its respiration must have required frequent access of air) that

it swam upon or near the surface, arching back its long neck like the swan, and occasionally darting it down at the fish which happened to float within its reach."

It may perhaps have lurked in shoal water along the coast, concealed among the seaweed, and, raising its nostrils to a level with the surface from a considerable depth, may have found a secure retreat from the assaults of dangerous enemies; while the length and flexibility of its neck may have compensated for the want of strength in its jaws, and its incapacity for swift motion through the water, by the suddenness and agility of the attack which they enabled it to make on every animal fitted for its prey, which came within its reach.¹

6. *Hylæosaurus*, No. 13 in plate (*hylæos, sylvan*; *sauros*, lizard, Remains, British Museum, Room III, case 10. Crystal Palace Restorations.) An animal resembling in many of its characters the *iguanodon*, and chiefly characterized by dermal bones, similar to those which form the exterior defence of some of the Australian lizards, and by a jagged crest extending along the middle of the back.

7. *Ichthyosaurus*, No. 14 in plate (*ichthys*, a fish; *sauros* a lizard, Remains, British Museum, Room IV, Jermyn Street Museum, Crystal Palace

¹ Abridged from Buckland.

Restorations.) In this animal, whose name includes a genus, the snout of a porpoise is combined with the teeth of a crocodile, the head of a lizard with the vertebræ of a fish, and the breast-bone of an ornithorynchus with the paddles of a whale. It had four of these paddles, which somewhat resembled broad feet, and its body terminated in a long and powerful tail. Some of the largest of these reptiles must have exceeded thirty feet in length. There are already discovered seven or eight species of this fossil creature, from the remains of which a very correct general idea of its structure has been gathered. The most extraordinary feature in the construction of the head is the enormous diameter of the eye, which very much exceeds that of any living animal, measuring, in one instance, fourteen inches across the orbital cavity. The jaws sometimes reach six feet in length, and are armed like those of crocodiles with teeth, the construction and arrangement of which, however, are somewhat different. A curiously constructed hoop of bony plates attached to the enormous eye, indicates that that organ must have been an optical instrument of varied and prodigious power, enabling the ichthyosaurus to descry its prey at great or little distances, in the obscurity of night or in the depths of the sea, enabling it to resist the pressure of deep water and pro-

tecting it from injury by the waves. The construction of the vertebræ indicate that, had these animals been furnished with legs instead of paddles, they would not have moved on the land without injury to their backs, while an apparatus for storing up a considerable quantity of air in the interior of the body seems to show that their *habitat* was the sea, and their means of living derived from patient diving in deep waters. Its paddles or organs of locomotion resemble in some respects those of the whale, and give to this animal all that is needed to ally it with the fishes; while its chest, formed like that of the most singular of living combinations—the ornithorynchus—giving it the power of easy, vertical movement in the water, affords a very striking example of the selection of contrivances to enable animals of one class to live in the element of another class. The fossil remains of this animal abound in England in the lias of Dorset, Somerset, Leicester, and York.¹

¹ Buckland's "Geology."

CHAPTER II.

THE MONSTER ANIMALS OF THE TERTIARY AGE.

IN the secondary strata which we have lately been contemplating, the closest examination has hitherto detected only the smallest traces of any of the mammalian tribes.¹ Two small creatures resembling the marsupials of New South Wales, and about the size of the mole, are as yet the only secondary representatives of these animals, and even in regard to these, the evidence depends on the characters of several fossil lower jaw-bones, on which geologists have found it difficult to agree.² But no sooner do we rise in the region of rocks, known as tertiary, ascending through their four divisions, designated respectively, eocene, miocene, pliocene, and pleistocene, than we begin to be surrounded by the wonders of a mammalian fauna, bearing a striking resemblance to that of our own times, though suffi-

¹ Lardner, 363. ² "Geol. Trans." 2nd series, vol. vi, page 58.

ciently contrasted with it at almost every point to mark a very different era in creation to the one to which we belong.

The saurian or lizard tribes have now sunk into comparative insignificance. They have been replaced by multitudes of animals of a nobler type, some of them active, graceful, and swift; others, gigantic, sagacious, terrible; and these continue to increase and multiply as ages roll on, not only by the propagation of the same species, but by successive creations of new orders of being, each higher stratum exhibiting various additions to those that had existed before.

That this tertiary period stands out distinct, equally from those that preceded it, and from that which has followed, will not be disputed when we remember that eight thousand species of animals are calculated to have lived in it, of which no representatives exist, either in the remains of the earlier, or in the living creatures of the later times. It was not, however, till towards the close of the ages which composed it, that the grandest features of its characteristic fauna were developed. Of the mammifers we find among the early strata of the series, several thick-skinned animals now extinct, an otter, a dog, and a squirrel. As we rise in these rocks, the genera increase with amazing rapidity, and their size and power become very remarkable.

At one particular point, no fewer than forty-seven new additions are detected, and among these, the remains of a great number strike us with astonishment, either on account of their mighty size, or their strange forms; and ere the tertiary gives place to recent times, closing with the lapse of its latest or *pleistocene* era, an immense accession has been made to these. Besides the mole, the hedgehog, the shrew, the badger, the polecat, and weasel, among the smaller quadrupeds, we find remains of the wolf and the otter, which exactly resemble in their anatomy the modern species of these animals.

Hyenas, bears, lions and tigers, much larger and more powerful than any that now exist, have left their remains in heaps among the mud and silt that cover the bottoms of ancient caverns, both in England and on the continent,¹ and indeed in all parts of the world, as we shall have reason to show in a future chapter. In that of Kirkdale, in Yorkshire, many bones were gathered and were examined, which gave evidence that they belonged to between two and three hundred hyenas of a kind similar to the striped species of Abyssinia, only larger and more formidable. There were in the same cave, remains of an animal resembling the huge, grisly bear of North America, but more powerful, whose teeth

¹ See Professors Owen and Ansted, &c.

indicated its aptitude rather for devouring vegetable than animal food. This animal was furnished with weapons of defence, which must have been formidable even to the gigantic lions and tigers of its own times.

The bones of many other mammalian animals now extinct, have been taken from the rocks of this tertiary age, which astonish us or fill us with awe as we contemplate them. The mastodon which spread itself over Europe, Asia, and America, a huge creature of the hippopotamus type;—the toxodon, a fossil skull of which, as described by Professor Owen, is twenty-eight inches in length and sixteen broad, with teeth adapted for gnawing like those of our weasels, or rabbits (rodentia), whose habits were aquatic, and which, though it was probably a quadruped, had something in common with the whale—a singular animal which must have been extremely sensitive, if we may judge by the large provision made for nerves and blood-vessels;—the macraucharia, of the same age and locality, a strange creature, which nothing of our day resembles, with a body as massive as the rhinoceros, and legs of corresponding strength terminated by three-toed feet, but in other respects more like the lama, its neck long and stiff, and its jaws fitted for the mastication of vegetable food;—the mylodon, whose skeleton, completely restored

in the British Museum, is one of the largest objects in the room it occupies;—the dinothereum, gigantic and terrible in its ponderous limbs;—the Irish elk, whose elegance and beauty must have equalled its strength and great proportions;—the monstrous hippopotamus of that age, well designated *major* by Cuvier;—the megatherium of Buenos Ayres, whose skeleton rears its huge bulk on the floor of the sixth room in the Geological Gallery of the British Museum;—the diprotodon and nototherium from Australia, whose proportions must have been enormous, and oxen of numerous varieties now unknown;—all these are examples well ascertained of the mammalian life of the tertiary age, and doubtless were brought into being by the creating word pronounced by the Omnipotent on the sixth day.

Long ere Adam lived these became extinct, and yet sometimes a curious link may be found between their era and our own. In 1799, a fisherman who earned his livelihood on the shores of the Frozen Sea, by seeking the tusks of the mammoth or Siberian elephant, one of the extinct animals of the tertiary, discovered one of these animals entire, frozen up in a block of stranded ice. Returning year after year, he found the body gradually more and more exposed, till at length, in 1803, it became disengaged and fell to

the sand. The fisherman cut off the tusks which measured nine feet seven inches, and allowed his dogs to feed upon the flesh still sufficiently preserved to attract them. Bears, wolves, and foxes, also visited the spot and satisfied their hunger on the remains. Ultimately the skeleton was discovered and carried away by an Englishman (Mr. Adams) in the employ of the Russian emperor, with the exception of one of the four legs which had disappeared. It is now to be seen in the museum at St. Petersburg. The skin, which is dark grey and covered with blackish hair, required ten persons to carry it ashore, and is also preserved. The height of this animal was nine feet seven inches; its length sixteen feet seven inches; and its tusks weighed three hundred and sixty pounds. The species to which it belonged, existed at the era we are now considering. Large tusks of these primeval animals and similar remains, are still so abundant amid the frozen wastes there, that what have been not inappropriately called ivory quarries, have been wrought among their bones for more than a hundred years. This race has been long since extinct, but its relics are found mingled with those of contemporary races over all the regions of the world, tropical as well as frozen. The neighbourhood of London has furnished many of these. The fishermen off the mouth of the

Thames, often bring up from the bottom of the sea, valuable masses of ivory. How strange is the link furnished by such facts between the tertiary age and our own !

The following are among the most remarkable and have been chosen for illustration. They are all in the second division of the plate.

1. *Dinotherium giganteum* (deinon, terrible ; therion, beast ; Remains, British Museum, Room VI,) said by Buckland and several other writers to have been the largest of terrestrial mammalia. Cuvier and Kaup, however, estimate its length at about eighteen feet, which, though enormous, is by no means the extreme length of the mammals of the tertiaries. It was furnished with a trunk like the elephant ; the shoulder-blade so nearly resembles that of the mole, that it indicates a peculiar adaptation of the fore-leg to the purpose of digging, which is corroborated by the extraordinary structure of the under jaw which was nearly four feet long. The aquatic tapirs is the family to which it was most nearly allied. It is distinguished, however, by two enormous tusks placed at the extremity of the lower jaw, like those in the upper jaw of the modern walrus. This animal is supposed to have frequented rivers and fresh-water lakes. To a creature of its habits, Buckland says, the weight of such tusks fixed in the under jaw would be no inconvenience, as

they were employed for raking and grubbing up by the roots, of large aquatic vegetables from the bottom, they would, under such service, combine the mechanical powers of the pickaxe with those of the horse-harrow of modern husbandry. The weight of the head placed above these downward tusks would add to their efficiency for the service here supposed, as the power of the harrow is increased by being loaded with weights. The tusks of the *dinotherium* may also have been applied with mechanical advantage to hook on the head of the animal to the bank, with the nostrils sustained above the water, so as to breathe securely during sleep, whilst the body remained floating at perfect ease beneath the surface. The animal might thus repose, moored to the margin of a lake or river, without the slightest muscular exertion, the weight of the head and body tending to fix and keep the tusks fast-anchored in the substance of the bank ; as the weight of the body of a sleeping bird keeps the claws clasped firmly around its perch. These tusks might have been further used, like those in the upper jaw of the walrus, to assist in dragging the body out of the water. and also as formidable instruments of defence.

In all these characters of a gigantic, herbivorous, aquatic quadruped, we recognize adaptations to the lacustrine condition of the earth, during that portion of the tertiary periods to

which the existence of these seemingly anomalous creatures appears to have been limited.

Cuvier mentions having discovered fossil fragments of the dinotherium in several places in France, in Bavaria, and in Austria, while Professor Kaup states that abundant remains of it are found at Epplesheim, in the province of Hesse Darmstadt.¹

2. Palæotherium (palaion, ancient; therion, beast; Remains, British Museum, Room V, where many animals of a similar type are represented in their osseous relics,) was much smaller than either of the last, seldom exceeding the size of a modern horse, and being sometimes found as small as a hare. Its remains are met with in abundance in the Isle of Wight and in the London clay, but are generally better preserved in the gypsum quarries of the Paris basin, in which more than twenty distinct species of extinct mammals have been detected. It was in this great charnel-house that Cuvier found the materials of which he built his fame as a comparative anatomist. "I cannot express," says he, "the pleasure I felt in seeing, when I discovered one character, how all the consequences which I predicted from it were confirmed. The feet accorded with the characters announced by the teeth. The teeth were in harmony with those previously in-

¹ See Buckland, Mantell, Kaup, Cuvier, &c.

licated by the feet," &c. Each species was in fact reconstructed from a single unit of its component elements. The palæotheria had incisors canine, and molar teeth.

3. The megatherium (mega, great; therion, beast; Remains, British Museum, where the gigantic skeleton, in a very perfect state, occupies part of the floor of Room VI.) An animal in some parts of its organization nearly allied to the sloth, and like the sloth presenting an apparent monstrosity of external form, accompanied by many strange peculiarities of internal structure which have hitherto been little understood, but which have fitted it for its destined office of subsisting entirely on trees. The province of the megatherium seems to have been to dig and consume the roots rather than to live upon the leaves, and this explains the incongruous proportions of its gigantic organs, all of which are well adapted to the functions which it had to perform. The anterior of the muzzle is so strong and perforated with holes for the passage of nerves and vessels, that we may be sure it supported some organ of considerable size; a long trunk was needless to an animal possessing so long a neck; the organ, therefore, was probably a snout like that of the tapir, sufficiently elongated to gather up roots from the ground. Having no incisors this animal could not crop the grass, and the structure of

the molars shows that it was not carnivorous. It is scarcely possible to imagine a more powerful engine for masticating roots than was formed by the teeth of the megatherium, to dig up and gather which, the limbs seem to have been peculiarly fitted. Thus, the clavicle or collar-bone is strong and curved, nearly as in the human subject; and as this bone is wanting in the elephant, the rhinoceros, and all large ruminating animals, we conclude that the fore-leg discharged some office different from that of locomotion. By its peculiar construction it was furnished with the means of rotatory motion, and it was terminated by a paw having some of the qualities of a hand, three fingers of which were bent obliquely inwards and furnished with long and strongly fitted claws rendering it unsuitable for rapid motion, but peculiarly adapting it for grubbing in the earth and tearing the strong roots of trees out of the soil. This occupation, for which the whole structure of its body seems to have been especially intended, required very little shifting from place to place, since one tree of ordinary size might supply many meals and the sustenance of many days, especially as the consumption of the roots may have been only preliminary to that of the leaves and branches. The entire fore-foot must have been about a yard in length, and it had another peculiarity in its mechanical con-

trivance which gave it the strength to sustain all the weight that might fall upon one of these members, while the animal seated on its hinder parts might be employed in using the other in the way described. Whatever inability for distant or rapid travelling may have attached to the structure now described, it was probably more than compensated by the extraordinary strength of the other parts of the body.

The posterior bones greatly surpass in size those of the largest elephant, enabling it to stand a great part of its time without leaning on the limb which was needed for digging. In this respect it greatly resembles the armadillo and chlamyphorus, both of which are continually grubbing in the earth for food. The hinder legs and feet are peculiarly strong in all their proportions, and like the anterior members better fitted for sedentary habits than for easy movement from place to place. Its tail was composed of solid masses of bone, and was much larger and more substantial than that of any other beast, extinct or living. It must have been intended to act, along with the posterior legs, as the third support of a tripod-like construction to which the creature owed the power of sitting upright for a long time on its hinder parts, without fatigue. Buckland supposed that the megatherium was clothed in armour like the armadillo, but recent

inquiries seem to have contradicted this idea, and our plate, in which I have followed the clever delineations of Mr. Waterhouse Hawkins, represents it, probably with more truth, as possessed of a hair-covered skin which perhaps resembled that of the elephant.¹

The habits of this animal have been further ascertained lately by Professor Owen, whose previous surmises have thus been fully confirmed. I extract the following from a short newspaper report of a lecture which he lately delivered at the Collegiate Institution, Liverpool. It relates to the megatherium :

“ A microscopical examination proved that the food must have been obtained in the same way as that of the sloth, not by climbing trees ; and then, how ? It first removed the soil from the root of the trees with its foot, and then it grasped the tree and prostrated it, its hind legs and its tail forming a tripod, from which the fore-limbs might act upon the trunk of the tree. When he first propounded this theory, Dr. Buckland objected that the animals would run the risk of getting their necks broken, to which he replied, that if they learnt some of the arts of prostration they might save themselves. At that time he had not the skull ; but when one was obtained, he found

¹ See Buckland's, “ Bridgewater Treatise,” new Edition, by Dr. Owen, &c.

it fractured in two places, one of which was over the right orbit, and entirely healed; the other was directly over the brain, and partially healed and new bone formed; but from a section he made, he found that the animal must have died from secondary causes from the last fracture. He found they were provided with double skulls, and the fracture was only of the upper or outer skull. But what inflicted the blow? If it had been some animal of prey, it would have finished its work, and death would have at once resulted; but there had been a healing, and a new bone formed, and this proved that the wound had been made by some cause, or agent, that could not repeat the blow; it was the falling tree, and his theory was proved."

4. Rhinoceros, (Remains, British Museum, Room V,) does not seem to have differed so much from those of its own genus in modern times as most of the other ancient animals, though M. de Blainville points out several distinctive marks between the existing and the fossil races. The bones have been found in many parts of Britain, in Italy, the south of France, and Belgium. The carcass of an entire rhinoceros was found about ninety years ago in the frozen soil of Siberia. The body and limbs, were clothed with brown hair, the head was extremely large and sustained two long horns, a

peculiarity which still belongs to the African species.

5. Mammoth (a word of Siberian origin, Numerous Remains, British Museum, Room VI) was an elephant of gigantic size, whose fossil remains are found, as stated in a previous page, in many parts of Northern Europe. The bones of a creature, resembling it in its general features, are also discovered in great quantities in the Sewalik Hills in India, and valuable contributions of these relics were some years ago sent home by Dr. Falconer and Sir P. T. Cautley, and are now to be seen in the British Museum. There is also a striking family likeness to the extinct mastodon which belonged to America, and whose name is derived from the conical projections on its teeth, (*mastos*, a hillock; *odous*, a tooth,) an animal also allied to the elephants, and of which an entire skeleton exists in the British Museum. The mammoths found in Siberia have a close coating of wool and much shaggy hair. The intimate structure of the teeth in the mammoth differs from that of the Asiatic and African elephant, and is supposed by Professor Owen to indicate that the creature lived on the coarser ligneous tissue of trees and shrubs. A valuable traffic is carried on with Siberia in the tusks of this enormous creature, the ivory of which is often of superior quality and brings a higher

price than that derived from modern animals. So prolific are some parts of that northern region that we must conclude their accumulation to be due to some aquatic agency, whereby the bodies have been floated into bays or estuaries where they have been entombed and from whence, as from mines, they are now dug.

6. Elk (Remains and restored skeleton, British Museum, Room V.) An animal greatly exceeding in size and power the modern races of the same genus.

CHAPTER IV.

DESTRUCTIVE ERA FOLLOWING THE
TERTIARY AGE.

LET us glance once more over the geological features of the later tertiary age. There we shall find that just when the organisms of that era have reached their highest perfection, and judging from the marks of steady progress which we can trace from the lower strata upwards to that point, where we may contemplate with the greatest satisfaction, the beauty and fertility which must have gladdened the earth, in an age glowing with the brightest colours and rich with the most abundant harvests, we are met by the unwelcome evidences of ruin and desolation.

Over all the rocks of the tertiary era are to be seen, by the most unpractised eye, the remains and evidences of this complete ruin. The clay of our wheat countries, the till of less fertile soils, the gravel and sand of our barren commons, the huge stones and scattered boulders that disfigure the sides of our mountain vales, and lie in hideous confusion on many an upland that faces

and confronts the opening of rapidly descending valleys, together with the scratched and abraded surfaces of the rocks and of the rolled stones in all such localities, everywhere tell the same tale and teach the same dread lesson.

These must have originated in the action of elemental powers whose force and universality it is impossible to exaggerate. They are confined to no locality. The mountain stream wears its way to the lowlands through banks of this *débris*. The railway cutting brings it to light in the plains. Wherever nature or art lays open the superficial deposits, the fact is demonstrated, that clay mingled with worn stones, scratched and striated, has been forced forward through an agency of inconceivable power, and laid in masses, often of enormous thickness over the earlier surface.

In the mountainous districts of our own land, the valleys are frequently filled with mounds of this mixed substance, which have been moulded in the act of their formation into forms of symmetrical rotundity. The Highland glens of Scotland and the dales of Westmoreland and Cumberland, present to British travellers the most striking illustrations of this remark. Along these beautiful valleys, green mounds, sometimes only perceptibly swelling above the common level, sometimes conical and of considerable

height, often oval, or in the form of a lengthened ridge sloping from the horizontal line above to the base, with all the regularity of a heap of corn on the threshing floor, sometimes clothed with trees, which, rising in regular verdure, occupy the foreground of many a striking picture, bear out its truth. These are composed of the clay and drift of which I speak, and where the improving hand of man has not materially altered their character, they are often found still encumbered with rocks and stones resting upon their surface, where doubtless they have lain ever since that all-pervading agency operated, whereby these mighty effects were produced.

There are some familiar facts which attest the might of the agencies that must have been employed, and the completeness of the superficial destruction which must thus have been occasioned. On the flanks of Mount Jura, for example, are to be seen, not far from Neufchâtel, some enormous boulders of protogine, a peculiar kind of granite, whose nearest site is on the valley of the Rhône, above its embouchure where it falls into the Lake of Geneva, seventy miles from the spot where now it lies. The boulder stone of Borrowdale, which forms one of the objects of surprise and interest to travellers in the lake district of Cumberland, must have also been carried a considerable distance by some similar agency; and that

enormous rock which forms the pedestal of the equestrian statue of Peter the Great at St. Petersburg, was found in a position which it could only have reached by forces of incalculable power. Northern Germany is strewn with enormous boulders torn at some distant day from the Scandinavian mountains.

There are various explanations given of the material causes of these wide spread phenomena. Dr. Lardner thus treats the subject:—"The disruption of the earth's crust, through which the chain of the great Alps was forced up to its present elevation, which, according to M. D'Orbigny, was simultaneous with that which forced up the Chilian Andes, a chain which extends over the length of 3,000 miles of the western continent, terminated the tertiary age, and immediately preceded the creation of the human race and its concomitant tribes. The waters of the seas and oceans, lifted from their beds by this immense perturbation, swept over the continents with irresistible force, destroying instantaneously the entire fauna and flora of the last tertiary period, and burying its ruins in the sedimentary deposits which ensued. Secondary effects followed, which have left traces on every part of the earth's surface."¹

Agassiz, agreeing as to the facts, attributes

¹ Pop. Geol. Section 552, 555.

the diluvial deposits to a different cause, and traces with remarkable ingenuity the appearances which they present, to the action of ice. Recognising in the fossils of the tertiary rocks (whose production we date from the sixth and seventh ages of the earth's Mosaic history,) the proofs of an era of remarkable profusion and fertility under warm and genial influences, he asserts that a season must have supervened when a universal and all-destroying cold suddenly invaded the world.

"A climate," he thus proceeds,¹ "such as the poles of our earth can scarcely produce,—a cold, in which everything that had life was benumbed, suddenly appeared. Could the animals which were created for a moderate tropical climate survive such a thorough change? Certainly not: for nowhere did the earth offer them protection against the omnipotence of the cold. Whithersoever they fled, into the dens of the mountains, which formerly had served to many of them as a lurking-place, or into the thickets of the forests, everywhere, they succumbed to the might of the annihilating element. The aqueous vapours, which the warm atmosphere of the earth must then have contained in great quantity, and the quantity of which was undoubtedly in proportion to the greater extension

¹ Article in Edinburgh New Phil. Journal, vol. xxxvi.

of the waters, and especially of the large internal lakes and morasses of the diluvial period, were upon that sudden change of temperature deposited in a solid form. A crust of ice soon covered the superficies of the earth, and enveloped in its rigid mantle the remains of organisms, which but a moment before had been enjoying existence upon its surface. In a word, a period appeared, in which the greater portion of the earth was covered with a huge mass of frozen water; a period in which all life was annihilated, and everything organic upon the earth was put an end to.

“This *glacial period* is the epoch of separation betwixt the diluvial period, as it has been termed by geologists, and our present period; it is it, which, like a sharp sword, has separated the totality of now living organisms from their predecessors which lie interred in the sands of our plains, or below the ice of our polar regions. Lastly, it is it, which has left to our times and testimonies of its former greatness, upon the tops and in the valleys of our Alps.

“I have followed its marks along the coasts of England, Scotland, and Ireland, and no doubt can now be raised in regard to the fact, that in our latitude the ice extended to below the level of the present sea. At many points of these coasts, I have, as far as my eye could penetrate

the water, seen these traces, deep below the surface; and so indelible are they, so deeply imprinted are these characteristic marks, that the roaring breakers have not even yet been able to erase them.

“On the other hand, the ice has imprinted upon all the mountain tops of Great Britain, which in Ben Nevis rise more than 4,000 feet above the level of the sea, the stamp which attests its former presence, and there can be no doubt that its colossal masses were piled up above the highest summits of these mountains.”

The marks to which the writer here alludes are thought to bear out the evidence of those boulder rocks already noticed, and to be simply traces which huge masses of ice have left behind them, in their downward grinding motion from the higher lands to the lowland valleys. We may judge of the character of these marks by what is daily seen passing in Alpine regions. Principal Forbes of St. Andrew's, spent much time and labour in investigating the motion of glaciers. By means of careful observations he discovered that this continues constantly by day and night, at a rate varying somewhat according to the state of the atmosphere. In conducting this inquiry, “The time,” he says, “was marked out as by a shadow on a dial, and

the unequivocal evidence which I obtained that even whilst walking on a glacier, we are day by day and hour by hour, imperceptibly carried on by the resistless flow of the icy streams, filled me with admiration."¹ It is this constant motion, which though it does not amount to more than fifteen or eighteen inches in a day, occasions indelible marks on the soil beneath, and on the rocky barriers through which the glacier makes its way. Along the edge which abuts upon a rising ground or mountainous precipice rocky fragments are strewn, which descend with the icy stream and are at length precipitated over the lowest part of it, forming a confused heap of boulder masses and smaller stones, known in Switzerland as a moraine. Some of them, however, find their way, much earlier, between the glacier and the sides of the valley, and are carried along by the descending weight, ploughing and furrowing as they crush along, and so leaving indelible markings on the rocks or the soil that may lie in their way. Lyell describes the process thus:—"All sand and fragments of stone which fall through fissures and reach the bottom of glaciers, or which are interposed between the glacier and the steep sides of the valley, are pushed along and ground down into mud, while the larger and harder fragments

¹ Professor Forbes's "Travels in Alps," p. 133.

have their angles ground off. At the same time the fundamental and boundary rocks are smoothed and polished and often scored with parallel furrows, or with lines or scratches produced by hard minerals, such as crystals of quartz, which act like the diamond upon glass. The discovery of such markings, far above the surface of existing glaciers and for miles beyond their present terminations, affords geological evidence of the former existence of the ice beyond its present limits, in Switzerland and in other countries.”¹

We have only to add to these statements that the discovery of precisely similar markings, in many regions far from Alpine and from modern glacial influences, gives an evidence quite of the same strength, that there also, at some former period, the power of descending masses had been felt. These markings lie within reach of most of us. The British tourist may with very little trouble, satisfy himself by personal observation of their existence in many localities which he is likely to visit, and which he may often perhaps already have passed, ignorant of the interesting memorials within his reach. The author has traced them, without leaving the beaten path more than a few yards, through various parts of the vale of Llanberis in North Wales, on the

¹ Lyell's "Prin. of Geol.," p. 227.

rocks of the mountain region that overlooks Windermere in Westmoreland, and in the gorge near Killarney, known as the Gap of Dunloe. Indeed it would seem that they may with some confidence be looked for in every contracted valley where the rocks still remain exposed and undisturbed.

There are marks of this overthrow still seen in caverns, whose contents till lately were sealed up from observation by accumulations of boulder drift, due no doubt to the dread agencies then in their resistless and all-pervading energy. On the floors of such subterranean chambers are found in great profusion, the bones of animals resembling the hyænas, lions, bears, tigers, &c., of the present times, but of proportions gigantic as compared with our contemporaries. These creatures had been for ages ere this time the familiar inhabitants of the regions where their relics are now found, and have met here face to face in what has proved their common grave. Mingled with their remains are also the bones of the hare, the cow, and the goat, probably not very unlike their congeners of the present day.

In our own island many caves exist, such as that of Kirkdale in Yorkshire, Kent's Hole in Devon, Oreston near Plymouth, and Paviland in South Wales, &c., which, when discovered, were thickly strewn with the bones of animals belonging to

racés, of which we may be allowed to doubt whether any direct descendants now exist on the earth; or rather, we are compelled to conclude that the ruin which involved these animals in death, was so universal, as not to leave one living representative to carry its kind across the gulf that separated, by a sudden stroke, these earlier ages from the later times in which we live. Remains of many of them may be seen in the British Museum, Room V.

We may try to conceive the scene of terror, of which these remains are now the only record, when, alarmed by the rush of waters sweeping with resistless force over the land, or driven by the pressure of still increasing cold and the steady invasion of ice and snow, the fiercer animals sought the dens which for ages had formed the dwelling-places of their kind, when the terror of the hour absorbed their dread of one another, and even the timid tribes shrunk not, as formerly, from the only shelter they could reach, though there they must encounter only their natural enemies. In that moment of universal alarm, the instinct of self-preservation had probably overcome all other influences, and here accordingly they may have mingled their outcries of terror and their dying groans, in one chorus of despair, as now they mingle their fossil remains in one undistinguishable heap of death.

This catastrophe seems the grand event which crowned the history of pre-Adamite ages, and prepared the way for the introduction of our race and the present orders of organized existences upon the face of the earth. Of the moral causes of a destruction so complete, and apparently so final, it is not our part here to speak. In another place¹ these facts are differently treated, and an attempt is made to account for them as occurring according to the recognised principles of the Divine rule revealed in the Word of God. To this we must be content at present with referring our readers, whose curiosity may urge them to enquire farther into a subject of the greatest interest, and on which there is a considerable amount of information within reach of the diligent enquirer.

¹ Pre-Adamite Man. Nisbet & Co.

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